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David J. Hostetler
Executive Director
Federal Regulatory

SBC Telecommunications, Inc.
1401 I Street, N.W.
Suite 1100
Washington, D.C. 20005
Phone 202 326-8811
Fax 202 408-4809
Email: dhostet@corp.sbc.com

November 16, 2001

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Office of the Secretary
Federal Communications Commission
445 12th Street S.W., Room TW-A225
Washington DC 20554

Re: Initiation of Cost Review Proceeding for Residential and Single-Line Business Subscriber Line Charge (SLC) Caps, CC Docket Nos. 96-262, 94-1.

Dear Secretary:

SBC Communications Inc. (SBC), on behalf of its price cap local exchange carrier (LEC) subsidiaries, hereby submits its subscriber line charge cost submission in response to the Commission's September 17th Public Notice in this proceeding.

We are submitting an original and four copies of the filing to the Secretary, one copy to the Commission's duplication contractor, and one copy with the Chief of the FCC's Competitive Pricing Division.

Please contact me at (202) 326-8111 if you have any questions.

Sincerely,

David Hostetler

SBC Subscriber Line Charge Cost Submission
Executive Summary
November 16, 2001

SBC Communications Inc. (SBC), on behalf of its price cap local exchange carrier (LEC) subsidiaries, hereby submits its subscriber line charge (SLC) cost submission in response to the Commission's September 17, 2001 Public Notice.[1] This executive summary consists of three sections: (i) a brief discussion of the background and purpose of the cost submission; (ii) an overview of SBC's cost model and the methodology used by SBC to determine the inputs for the cost model; and (iii) a summary of results. SBC's cost submission demonstrates that there is no basis for revising or reconsidering the scheduled increases in the SLC caps.[2]

1. The Purpose of the Cost Submission

On May 31, 2000, the Commission adopted the integrated interstate access reform and universal service reform plan submitted by the Coalition for Affordable Local and Long Distance Service (CALLS).[3] One of the primary benefits of the CALLS plan is that it removes implicit subsidies from the interstate access charge system and replaces them with explicit end user recovery and a new interstate access universal service support

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[1] *Initiation of Cost Review Proceeding for Residential and Single-Line Business Subscriber Line Charge (SLC) Caps*, CC Docket Nos. 96-262, 94-1, Public Notice, DA 01-2163 (rel. Sept. 17, 2001).

[2] 47 C.F.R. § 69.152(d)(ii). The SLC recovers the interstate allocation of the loop and port elements.

[3] *Access Charge Reform et al.*, Sixth Report and Order in CC Docket Nos. 96-262 and 94-1, Report and Order in CC Docket No. 99-249 and Eleventh Report and Order in CC Docket No. 96-45, 12 FCC Rcd 15982 (1997) (*CALLS Order*).

mechanism.[4] Of particular relevance to this proceeding, the plan immediately eliminated residential and single-line business PICC and established a schedule for gradually increasing the primary residential and single-line business SLC cap to $6.50 on July 1, 2003. The Commission concluded that the rate restructuring provided for in the CALLS plan serves the public interest "because it simplifies the current rate structure, moves toward cost-based rates, reduces consumers' overall rates, and simplifies long distance bills, thereby resulting in less consumer confusion."[5]

In response to concerns of consumer groups and state commissions, the CALLS plan provided for Commission verification that the progressive increase in the primary residential and single-line business SLC above $5.00 is appropriate in the UNE zone or zones where they would apply.[6] To facilitate this verification, SBC and other CALLS members agreed to provide the Commission with "economic data, including data identifying the forward-looking costs associated with the provision of retail voice grade access to the public switched telephone network for those areas."[7] In the *CALLS Order*, the Commission decided that it would examine this forward-looking cost information prior to the scheduled increase of the SLC cap above $5.00 on July 1, 2002.[8] The Commission rejected proposals to require a cost study prior to adopting the CALLS plan

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[4] *Id.* at ¶¶ 2-3.

[5] *Id.* at ¶ 81.

[6] Memorandum in Support of the Revised Plan of the Coalition for Affordable Local and Long Distance Service, at 10 (filed Mar. 8, 2000).

[7] *Id.*

[8] *CALLS Order* at ¶ 83.

because it did not want to delay the immediate savings end users would realize from implementation of the plan.[9]

In reviewing SBC's cost submission, it is important for the Commission to remember that *this is not a ratemaking proceeding*. The purpose of the Commission's cost review proceeding is simply to verify that the scheduled increases in the SLC cap are warranted. Given the billions of dollars of upfront reductions mandated by the CALLS plan, it is reasonable and appropriate for price cap LECs to recover at least some of these reductions through gradual SLC increases. Moreover, the maximum primary residential and single-line business SLC in any UNE zone will continue to be the *lower* of the SLC cap or the average price cap common line, marketing and transport interconnection charge (CMT) revenue per line for the highest cost UNE zone in a study area.[10] Therefore, an increase in the SLC cap will not necessarily result in an increase in the actual SLC being assessed by a price cap LEC in a given UNE zone.

The Commission also should consider the fact that the CALLS plan permits (indeed encourages) deaveraging of the SLC in different UNE zones. The Commission has recognized that deaveraged rates more closely reflect the actual costs of providing service, which promotes competition and efficiency by removing implicit subsidies.[11] In analyzing whether the scheduled increases in the SLC cap are warranted, the Commission must consider the extent to which the existing cap level prevents price cap LECs from

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[9] *Id.* at ¶ 84.

[10] 47 C.F.R. § 69.152(d)(ii).

[11] *CALLS Order* at ¶ 114.

deaveraging the SLC as intended. As demonstrated below, maintaining a $5.00 cap would significantly impede SBC's ability to implement deaveraged SLCs in different UNE zones.

2. SBC's Forward-Looking Cost Study

SBC is submitting a number of technical documents that explain its forward-looking cost model and the methodology used to determine inputs to the cost model. Once again, SBC's cost study is not designed to establish the correct price for residential voice grade local telephone service, but rather to document the costs of provisioning such service. SBC utilized a computer model to calculate the forward-looking cost of the loops and ports that comprise residential voice grade telephone service. SBC then applied a percentage of shared and common costs to arrive at a total cost per line. This total, in turn, was divided by four to derive the appropriate interstate allocation for each line.

Attachment 1 is an overview of SBC's forward-looking cost study, including the methodology used to determine cost inputs and the computer models that were used to derive forward-looking loop and port costs. SBC has used a long run incremental costing methodology to determine the direct costs of provisioning residential voice grade telephone service. This study process reflects relevant aspects of the existing network (*e.g.*, locations of central offices), as well as cost data reflective of forward-looking technologies. The numbers reflected in the attached documents are illustrative only. SBC is not providing the actual inputs for the cost models, which are proprietary and competitively sensitive. SBC's overview describes the assumptions and factors that were used to calculate an annual cost per line.

Attachments 2 and 3 provide a textual description of the computer models that SBC used to determine loop and port costs, respectively. The SBC Loop Costing System calculates the forward-looking costs of a local loop in the SBC networks, including investment, monthly recurring capital costs and operating expenses associated with this plant investment. It does not measure historical or embedded loop costs. Similarly, the SBC Switching Information Cost Analysis Tool Documentation calculates the forward-looking cost of switching in the SBC networks. The only switching costs that have been included in this cost study are investment per analog line and investment per digital line, which correspond to port costs.

Attachment 4 describes the methodology used to allocate shared and common costs. SBC's methodology assumes an 11.25% authorized rate of return and includes common costs such as uncollectibles, marketing expenses, call completion, customer services, general administrative expenses and operating taxes.

3. Summary of Results

SBC calculated the total forward-looking cost per line for each study area (*i.e.*, each state) by adding the interstate allocation of the loop and port costs and applying the appropriate shared and common cost percentage. SBC then calculated the forward-looking cost per line for each UNE zone within each study area. Rather than using state-specific UNE zone categorizations, SBC has uniformly categorized UNE zones from the lowest-cost zone (Zone 1) to the highest-cost zone (Zone 3 or 4). Attachment 5 is a table showing the results for each study area and each UNE zone within SBC's territory.

The results of SBC's forward-looking cost analysis provide strong support for allowing the SLC to gradually increase to $6.50 as provided for in the Commission's rules. In particular, the average forward-looking cost per line is above \$6.50 in more than half of SBC's states and it is more than \$7.00 in five states. The deaveraged forward-looking per line cost varies widely from a low of \$3.43 in Illinois Zone 1 to a high of \$14.95 in Kansas Zone 3. This variation provides further support for raising the SLC cap so that the SLC can be deaveraged to reflect cost differences in UNE zones.

To illustrate the practical effects of raising the SLC cap, Attachment 5 also shows the CMT revenue for each study area in SBC's territory. Because most of these CMT revenue figures are below the \$6.50 cap, SBC will not be able to increase the SLC to the cap in many cases. SBC, however, will have greater flexibility to deaverage its SLCs, which is consistent with the rules adopted in the *CALLS Order*. Thus, SBC's cost information provides compelling support for the Commission to reaffirm that the scheduled increases in the SLC cap are warranted.

Attachment 1

Overview of the
Cost Studies
Conducted for the
FCC Subscriber Line Charge
Proceeding

CC Docket Numbers 96-262, 94-1, 99-249, 96-45

November 16, 2001

Table of Contents

1.0 Introduction

1.1 Purpose of this Document

The purpose of this document is to describe the studies created by SBC to determine the costs of providing the loop and switch port for a residential and business line. This document describes the study methods, models, input data and results.

1.2 Basis for Loop and Switch Port Studies

On May 31, 2000, the Federal Communications Commission adopted an integrated interstate access reform and universal service plan for price cap local exchange carriers ("LECs"). The proposal was put forth by the members of the Coalition for Affordable Local and Long Distance Service (CALLS). The CALLS plan establishes a schedule for gradually increasing the residential and single-line business subscriber line charge (SLC) cap to $5.00 as of July 1, 2001, $6.00 as of July 1, 2002, and $6.50 as of July 1, 2003. The Commission has asked for cost information prior to the increase of the SLC cap above $5.00.

The two-wire loop cost studies and the switch port cost studies were conducted in support of this effort. The two-wire loop cost studies determined the direct forward-looking average recurring Long Run Incremental Costs (LRIC) for SBC to provide the facilities between SBC central offices and the customer premises that provide telephone service for residential and single-line business customers. The switch port cost studies determined the LRIC to provide the line-side loop or ground-start signaling connection that is used primarily for analog line connection for switched voice communications.

1.2 Overview of Study Process

The SBC cost study process has evolved over many years. Its purpose has been to determine the costs of offering new and existing services in order to set tariffed rates. The cost methodology which has been used is called *long run incremental costing*. This methodology determines the *direct costs* which will be incurred by SBC in providing a service during a future planning period.

The study process includes:

- *Real Network Characteristics*. Cost studies are "forward-looking" in the sense that they calculate the cost to provide network elements using the latest plant technology for local loop facilities, switching, and other elements of the network. At the same time the studies reflect relevant aspects of the existing network, such as locations of central offices, customer premises, and others. Based on the characteristics which determine the network today and influence it in the future, the studies calculate the plant investment and operating costs which would be expected using forward-looking technologies.

- *Forward-Looking Cost Data*. Along with using forward-looking plant technologies, the studies use plant cost data (vendor prices, labor costs, etc.), capital cost factors and operating expenses which are reflective of these forward-looking technologies.

- *Quality Assurance.* Finally, an important part of the cost study process is "quality assurance." Studies are reviewed several times for accuracy, consistency in the application of costing methods and cost data, and completeness.

2.0 General Study Approach

2.1 The Cost Question

In calculating forward-looking costs, SBC cost analysts answer the following question:

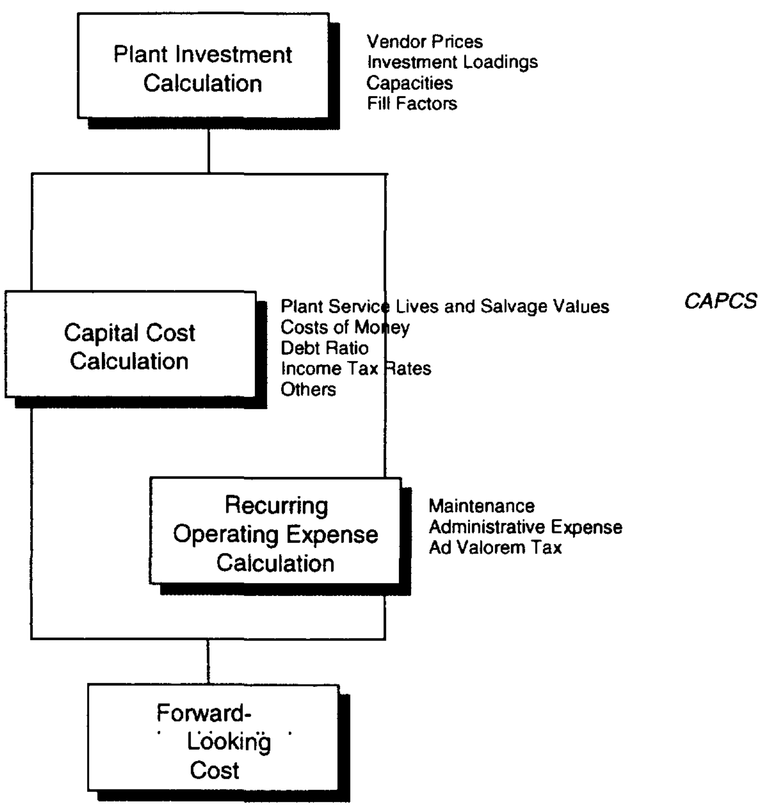
> *What are the forward-looking, long run incremental costs for a service recognizing SBC's existing network and using forward-looking, efficient technologies, with network maintenance and operations reflecting these technologies?*

The cost analyst computes these forward-looking plant costs reflecting current vendor prices and discounts for equipment, current engineering and labor costs, etc. Plant maintenance and other operations reflect systems and procedures associated with these forward-looking technologies. In summary, forward-looking costs reflect a forward-looking network operation with regard to wire center locations.

2.2 Study Flow

The general flow of the cost study is shown in Figure 2.1. The first step is to calculate the *plant investment.*

Figure 2.1



The plant investment required to provide a service consists of several (perhaps many) plant components. For example, the plant necessary for a local loop consists of parts of the main distributing frame in the central office, distribution and feeder cables, feeder-distribution interfaces, premises terminating equipment and others. Plant investments are computed for each component reflecting the mix of equipment used today to provide the component, appropriate equipment quantities, vendor prices, capitalized engineering and labor costs, support assets (such as power equipment and buildings) and others.

Plant investments per unit of a service are then computed by dividing the plant investment necessary for each component by its *expected capacity utilization.* Expected capacity utilization is simply the *physical capacity* of the plant component multiplied by its *fill factor* or *utilization.* This gives a measure of the amount of investment that would be required using forward-looking technologies to provide a service or component.

In the second step, *annual capital costs* are calculated. These include *depreciation expense* for the recovery of plant investment over its service life, a return requirement or *cost of money* associated with investor-supplied capital used to construct the plant, and an *income tax* obligation associated with the equity portion of the cost of money. SBC computes capital costs using a model called CAPCS.

Forward-looking costs also include *recurring operating expenses* associated with the maintenance of plant, network administration functions, support assets, miscellaneous other operating taxes and a commission assessment on revenues received in providing network elements to other carriers. Operating expenses are computed using various expense factors that are unique to each type of plant, recognizing different levels of maintenance and network administration necessary for different plant types. Total costs then are the sum of the recurring capital costs and operating expenses associated with the plant required to provide the network element.

2.2 Study Assumptions

The studies conducted for the FCC Subscriber Line Charge proceeding contain certain assumptions that were used to determine the company's costs for providing the network operations related to loop and switch port services

- *Planning Period.* The planning period assumed for SBC's cost studies in this proceeding includes the years 2002 through 2005.

- *Cost of Money.* The cost of money assumed within the studies reflect the company cost of capital, taking into account the company's expected rate of return on investments and the opportunities and risks the company experiences within its industry.

- *Capital Investment Depreciation Lives.* The depreciation lives assumed for the capital investments within the studies reflect the economic lives of the investments.

- *Use of Proxy Information.* There were instances in which detailed state specific information necessary to complete the cost studies could not be gathered within the time constraints of the proceeding. In order to complete the studies, information from states with similar characteristics were used. In particular, Texas in-place cost information for installed cable and other outside plant components was used in the California study; Missouri in-place cost information for cable and outside plant was used in the Connecticut, Illinois, Indiana, Michigan, Nevada, Ohio, and Wisconsin studies. Also, annual charge factors from Indiana were used within the studies for Illinois, Michigan, Ohio and Wisconsin.

3.0 Loop Cost Studies

3.1 Study Purpose

The Loop Cost Study calculates the cost to SBC to provide a loop assuming a local network based on forward-looking plant technologies and costs of plant construction. A loop consists of the telephone plant from the *network interface device* at a customer's premises to the serving central office of SBC.

For each loop, costs are computed for three geographic zones corresponding with rural, mid-size and large, urban wire centers. Loop costs vary among the geographic zones due to differences in loop length, cable mixes and sizes, and other factors which vary among the zones.

Loop costs are expressed as a *recurring monthly cost* which includes capital costs (depreciation, the cost of money and income taxes) and operating expenses for ongoing plant maintenance, network administration and other activities. Figure 3.1 illustrates the costs calculated in the loop cost study.

Figure 3.1

Unbundled Loop Cost Study Results

Loop Recurring and Non-Recurring Costs

Type of Loop	Geographic Zone	Recurring Cost	Non-Recurring Cost Initial	Non-Recurring Cost Additional
8db Loop	1	$XX.XX	$XX.XX	$XX.XX
	2	$XX.XX	$XX.XX	$XX.XX
	3	$XX.XX	$XX.XX	$XX.XX
BRI Loop	1	$XX.XX	$XX.XX	$XX.XX
	2	$XX.XX	$XX.XX	$XX.XX
	3	$XX.XX	$XX.XX	$XX.XX
DS1 Loop	1	$XX.XX	$XX.XX	$XX.XX
	2	$XX.XX	$XX.XX	$XX.XX
	3	$XX.XX	$XX.XX	$XX.XX

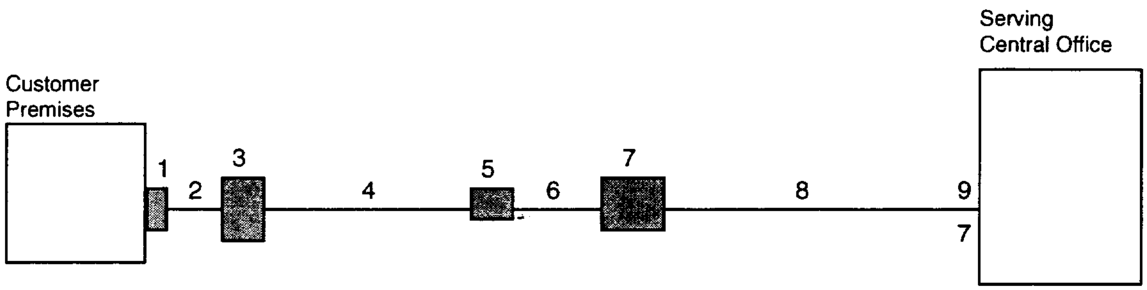
3.2 Loop Components

An 8db loop includes SBC plant from the customer premises, through distribution and feeder cable facilities, to the main distributing frame in the serving central office. Figure 3.2 illustrates the components of an 8db loop.

- *NID and Drop Cable.* The network interface device (NID) and drop cable are referred to as *premises termination equipment* in the loop cost study. They provide the transmission path from the last cable spice in the outside plant network to the customer's premises. The 8db loop cost study recognizes two possible configurations of premises termination - one involving a singe pair of wires to the customer premises, and the other two pairs. A weighted average of costs for the two configurations is used in the study.

- *Distribution Cable.* The copper cable which runs from the feeder-distribution interface to the terminal located near the customers premises. *The feeder-distribution interface* is the "cross-connection" point between the feeder cable from the serving central office and the distribution cable. A mix of aerial, buried and underground cables is used in the study. The cable mix varies by geographic zone. Pole and conduit investment to support distribution cable also are included in the loop cost calculation.

Figure 3.2



1. Network Interface Device
2. Drop Cable
3. Terminal
4. Distribution Cable
5. Feeder-Distribution Interface
6. Feeder Stub
7. Digital Loop Carrier System
8. Feeder Cable
9. Main Distributing Frame Stringer

- *Feeder Stub and Digital Loop Carrier (DLC) System.* When loop feeder cable lengths exceed a certain threshold (typically 12,000 feet), fiber feeder cable and digital loop carrier systems are used in the cost study as the most efficient loop design. In this case a feeder stub or section of cable is required to connect the feeder cable to the DLC equipment.

  The digital loop carrier system requires circuit equipment located in the field. Approximately 75% of the time circuit equipment is required at the central office as well. The DLC equipment provides multiplexing of voice channels over the fiber cable between the serving central office and the feeder-distribution interface. The study assumes three system sizes with 192, 672 and 1,344 channels of capacity. The amount of DLC investment per loop depends upon the frequency of fiber versus copper feeder, the percentage of integrated DLC systems (which do not require central office terminating equipment), system size and expected utilization of the system (fill factor).

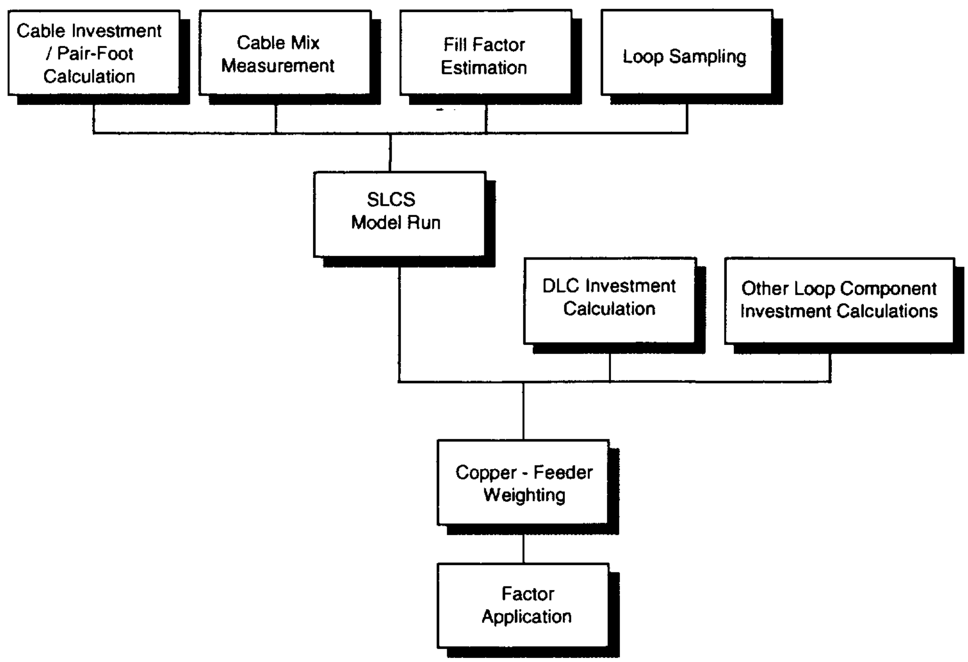
- *Feeder Cable.* Copper or fiber cable running from the serving central office to the feeder-distribution interface or remote DLC terminal. The cost study reflects a mix of aerial, buried and underground cables depending upon the geographic zone. Copper feeder is assumed for loops with feeder cable lengths less than 15,000 feet. As with distribution cable, pole and conduit plant investment is included in the loop cost calculation.

- *Frame Stringer.* Equipment connecting outside plant cables to the Main Distributing Frame. Includes a protector unit, protector block, riser cable and the labor cost to place the equipment.

3.3 Study Flow - Recurring Monthly Costs

As described earlier, loop costs include the *recurring monthly costs* Southwestern Bell incurs in providing loops and the *non-recurring costs* to provision the loop. In this section, the study flow for computing recurring monthly costs is described. The study flow is illustrated in Figure 3.3.

Figure 3.3



The loop cost study uses several interrelated models and special studies. SLCS is the primary model in the study. It is used to compute *the plant investment per loop for the distribution and feeder cable components* of the loop. Plant investments are computed for the three geographic zones based on loop characteristics in each zone. These characteristics include:

- *Loop length.* Samples of actual loops in service are used to determine average loop lengths in zones 1, 2 and 3. (See Section 3.4.)

- *Mix of cable types.* Different proportions of aerial, buried and underground cable are used in rural, mid-sized and urban wire centers. These are based on a study of cable types in service. (See Section 3.6.)

- *Installed cable costs per pair-foot* by cable type and wire gauge (26, 24, 22, and 19 gauge). Installed cable costs vary depending on the size of cable in terms of pairs per cable. Calculations are made to determine the mix of cable sizes, and based on this mix installed cable costs per pair-foot are determined for each combination of cable type and wire gauge. (See Section 3.5.)

- *Fill factors*. Other calculations are made to determine actual utilization levels for copper distribution cables, copper feeder cables and fiber feeder cables. (See Section 3.7.)

These characteristics are measured for the existing local facilities network. Adjustments then can be made if characteristics are expected to be different in the future. SLCS also determines investments in poles and conduit structures per loop based upon investment loading factors.

In parallel with the calculation of distribution and feeder cable investments per loop, the investments in digital loop carrier systems and the other loop components are computed. The latter includes the premises termination equipment, feeder-distribution interface, feeder stub, and main distributing frame stringer. Each of these additional loop investments is calculated using a special study created by a cost analyst with input from company databases or from subject matter experts in engineering.

3.4 Loop Samples

Loop length is a key driver of loop costs ... the longer the loop, the more plant investment that is required. Since the object of the loop cost study is to determine the forward-looking cost to serve the total demand for loops, *average loop lengths* must be estimated for all loops in each geographic area.

Rather than measure the lengths of all loops, a representative sample is taken at random. In random sampling, the number of samples which must be taken to accurately measure the average of the population depends on several factors:

- *Variability*. The more loop lengths vary within a study area, the greater the chance the average loop length of a sample is significantly different than the true average. Sample sizes must be larger when loop lengths vary significantly. On the other hand, geographic areas which have less variance in loop lengths require smaller samples. Small sample sizes often provide very good estimates of the true average.

- *Confidence Interval*. When a sample is taken and the average loop length is computed, some assurance is needed that the true average is within a reasonable range around the sample average. Typically, a 95% confidence interval is used. This means the cost analyst can assume there is a 95% chance the true average is within this range. The confidence interval can be "tightened" to a satisfactory range by increasing the sample size.

- *Size of the Population*. The larger the population of loops the greater the chance a random sample will be representative. In SBC studies loop populations typically number in the hundreds of thousands.

The sampling techniques used by SBC determine proper sample sizes. Samples are taken at random from the company databases which maintains records of the characteristics of the lines in service. The system records actual lengths of feeder cables and provides estimates of distribution cable lengths. Once a valid sample of several hundred loop lengths is obtained, the data are entered in the SLCS model to compute average feeder and distribution cable investments per loop.

3.5 Cable Investment / Pair-Foot

Cable costs are measured by linear foot and vary by *cable type, wire gauge* and *cable size*. For example, assume a foot of buried cable with 26 gauge wire in a 200 pair cable size has an installed cost of approximately $5.00. This figure includes the cable material, telco engineering and labor, miscellaneous materials and contractor charges for placing the cable. Similarly, buried cable comprised of 300 pairs of 26 gauge wire might cost about $1.00 more per foot, or $6.00.[1]

Loop cable plant is made up of numerous sections of cable of various cable type, wire gauge and cable size. To calculate loop investments it is necessary first to compute a cable cost for the mix of cable sizes in a geographic zone. This figure is expressed as a *cable investment / pair-foot of cable capacity*. Separate investments / pair-foot are computed for each cable type and wire gauge. These *unit investments* are applied to the average loop lengths from the loop samples to compute loop investments.

In the example above, the first 26 gauge buried cable requires an investment of $0.0250 per pair-foot, and the second cable $0.0200 per pair-foot. A unit investment for 26 gauge buried cable in each geographic zone is computed based on the weighted average of these and other cable sizes in the zone. This average reflects both *feeder* and *distribution* cables.

Since feeder cables tend to be larger than distribution cables, the cable cost per pair-foot for feeder cable is less than the cost of distribution cable. To reflect this difference, the unit investment for feeder and distribution cables combined is "deaveraged" between feeder and distribution cables. This is done in two steps. For example, the unit investment for *buried feeder cable* is calculated based on the quantity of each FDI size. Then, the unit investment for distribution cable is "solved for" based on the unit investment for feeder and distribution cables combined, the feeder unit investment and the relative proportion of feeder and distribution cable lengths in a geographic zone. Figure 3.4 illustrates the level of detail of cable unit investments for each of three geographic zones.

[1] Cable costs are obtained from SBC's Engineering records of current outside plant construction cost data. These data are used by engineers in planning current outside plant construction projects. Cable costs are adjusted to reflect any change in cable cost anticipated in the near future.

Figure 3.4

Geographic Zone

Copper Feeder Cable

Cable Type	Wire Gauge 26	24	22	19
Aerial Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX
Buried Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX
Underground Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX

Copper Distribution Cable

Cable Type	Wire Gauge 26	24	22	19
Aerial Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX
Buried Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX
Underground Cable	$0.XXX	$0.XXX	$0.XXX	$0.XXX

Fiber cable investments / pair-foot are computed for buried and underground cables. First, fiber costs per foot are obtained from Engineering's cable construction cost data. The cable sizes used in the study are 24 fiber cable for zone one, 48 fiber cable in zone 2, and 144 fiber cable in zone 3. Contractor placement costs and innerduct costs (for underground cable) are added. The total installed cost per foot for each cable size then is divided by the number of fibers per cable (24, 48 or 144) to compute the installed cost / fiber-foot.

Four fibers are assumed for each DLC system. Consequently, the installed cost / fiber-foot for each cable size is multiplied by four fibers to compute the installed cost / foot and DLC system. This figure is divided by the voice grade channel capacity of the DLC systems to arrive at fiber cable investments / pair-foot.

3.6 Cable Mix Measurement

The relative proportions or mix of cable types (*percentages of aerial, buried and underground cables*) for loop distribution and feeder cable in the geographic zones is determined by measuring in-service quantities (total cable sheath-feet) of each cable type. Two measurements are required. Cable mixes are separately computed for distribution and feeder cables by zone based on the resulting quantities of each cable type.

3.7 Fill Factor Estimation

Fill factors are based on actual plant utilization. A separate fill factor is calculated for feeder cable, distribution cable and DLC systems. The cable factors are computed by dividing the number of working pairs by the number of available and spare pairs in each cable route. The DLC fill factor is based upon actual DLC channel utilization.

3.8 Loop Cost Model

The SBC Loop Cost System (SLCS) is the cost model used to compute forward-looking loop plant investments. The model relies on the cost data described in Sections 3.4 - 3.7. These data include loop lengths divided between distribution and feeder cable for a sample of loops in each geographic zone, cable investments / pair-foot of capacity, cable mixes and fill factors. Two additional input items - pole and conduit plant investment factors - also are used in SLCS to compute the investment in structures required to support cables.

To calculate *loop plant investments for distribution and feeder cable* by geographic zone the following steps are used by SLCS:

- *Calculation of average loop length.* The distribution and feeder cable lengths are calculated based on a sample of loops taken at the state or the zone level.

- *Distinction of loops with copper and fiber feeder cable.* Loops with feeder cables above and below the copper - fiber cutover point (12,000') are separated. Therefore, for each geographic zone there actually are three frequency distributions - one for the distribution cable portion of loop length, another for the feeder cable portion of the loop when the loop design calls for copper feeder cable, and the third for the feeder cable portion of the loop when fiber cable is used. The three distributions, in effect, are used to compute average lengths of distribution cable, copper feeder cable and fiber feeder cable.

- *Mix of wire gauge.* SLCS also distinguishes the mix of wire gauges for copper distribution and feeder cables. Since the electrical resistance in copper wire increases with length, SLCS contains tables which indicate the maximum distance at which the smallest gauge wire (26 gauge) can be used, at which point the next size wire (24 gauge) is used until its limit is reached. Thus, SLCS estimates the average length and mix of wire gauges for copper distribution and feeder cables in rural, mid-sized and urban wire centers.[2]

- *Mix of cable types.* In the proceeding steps, SLCS computes average copper distribution and feeder lengths by wire gauge, and an average fiber feeder cable length. Since the cables are a mix of aerial, buried and underground cable, the next step is to apply the percentages of each cable type to the average lengths. These percentages vary for copper distribution, copper feeder and fiber feeder cables.

[2] Gauge measurements do not apply to *fiber* feeder cable. In this case, SLCS simply determines average feeder cable length for loops with feeder cable exceeding the 12,000' threshold for fiber cable.

- *Cable investments / pair-foot in service.* Section 3.5 described the special study used to compute cable investments / pair-foot of *capacity* for each cable type. Because not all cable pairs will be in service, it is necessary to adjust the cable unit investments to reflect expected utilization. This is done by dividing the unit investment for each cable type by the fill factor. (See Section 3.7.) This calculation yields an amount equal to the cable investment / pair-foot *in service.*

- *Loop investments.* The cable investments / pair-foot in service then are applied to the average cable lengths to determine the investment in distribution and feeder cables in each geographic zone.

- *Structures investment.* In addition to the investment in cable, loops also require investment for poles and conduit. These investments are calculated by applying ratios of structure investment to cable investment to the aerial and underground cable portions of loop investment. This step completes the SLCS investment calculations, and the results are carried forward to be summarized with the digital loop carrier and other loop component investments described in Sections 3.9 and 3.10.

3.9 Digital Loop Carrier Investment

Digital loop carrier (DLC) systems are assumed for loops with *feeder cable lengths* above a certain threshold - typically 12,000 feet. A DLC system consists of digital electronic circuit equipment which enables many voice channels to be combined over the same fiber. This is accomplished using "time-division multiplexing." The result is lower costs and better transmission than traditional copper cables for loops with long feeder cable lengths.

Three sizes of DLC systems are used in the loop cost study. The smallest system has a capacity of 192 voice channels and is used in the rural geographic zone. The second system has 692 channels of capacity and is used in the mid-size geographic zone. The third system handles up to 1,344 channels in the urban zone.

One of the key factors underlying DLC costs is whether the system is "integrated" with the serving end office. An integrated DLC system is connected directly to the switching system such that digital signals from subscribers do not have to be "demultiplexed" and converted to analog signals. This saves from having to have *central office terminating equipment* for the DLC system. Non-integrated DLC systems require central office terminating equipment to demultiplex signals and covert them to analog signals as they were before entering the DLC system. In both cases, DLC equipment, called *remote terminating equipment,* is required in the field. The loop cost study calculates DLC investment per loop reflecting a relative frequency of integrated and non-integrated systems.

DLC investments are computed in a special study which identifies the equipment components, quantities, current material prices and engineering and labor to construct the three sizes of DLC system. DLC investments per loop are calculated by dividing the DLC investments by the expected channel utilization for each system. The latter is computed by dividing the physical capacity of each system (192, 672 or 1,344 voice channels) by the DLC system fill factor. This factor reflects the expected utilization of the system.

3.10 Other Loop Components

The investments in distribution and feeder cables and the digital loop carrier system typically represent 90% or more of the investment in loop plant. There are several other important loop components included in the study. These are illustrated in Figure 3.2 and described below:

- *Premises termination equipment (NID and drop cable).* An 8db loop requires a single premises termination with a one or two pair drop cable. Investments are computed for one and two pair drop cables and weighted based upon the frequency of each. Premises termination investment includes the equipment costs of the network interface device and drop cable, as well as labor costs for installing the equipment and cable splicing. Cost data are from Engineering's outside plant construction cost data.

- *Feeder distribution interface (FDI).* The FDI investment represents the cost of the cabinet and equipment providing the cross-connect point between the feeder and distribution cables. FDI investment per loop is computed based on an analysis of the number of FDI boxes of various line sizes and the installed costs of each.

- *Feeder stub.* The feeder stub investment is calculated based on an average feeder stub length derived from a random sample and the installed cost / pair-foot for feeder stub cable. The unit investment for the stub cable is divided by the fiber feeder cable fill factor to allow for the cost of spare capacity in the feeder stub.

- *Main distributing frame stringer.* Frame stringer investments include the costs of a protector unit and protector block, the riser cable connecting the outside plant cable to the main distributing frame, and installation labor. Investments are calculated for copper feeder cables and fiber feeder cables. Unit investments are increased by the copper or fiber feeder cable fill factors to recognize the costs of spare frame stringer equipment.

After these special studies for the other loop components are completed, loop investments are summarized for each geographic zone on a "loop spreadsheet" Figure 3.4 illustrates the type of cost information which is contained. Note that the investments for copper and fiber feeder cables, the DLC system and the feeder stub are multiplied times a frequency factor to reflect the percentage of loops which are provided using these components. The primary purpose of the loop spreadsheet is to summarize loop investment by account so that capital cost and operating expense factors can be applied to the investments to calculate recurring monthly costs.